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Comparison of the Accuracy of Boey Score and PULP Score in Prediction of Gastric Perforation Mortality at Dr. Mohammad Hoesin General Hospital Palembang

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A B S T R A C T

Background: Gastric perforation, whose clinical features vary, and the frequent delay in diagnosis may lead to high mortality. The Boey and PULP scores were developed to predict mortality in order for high-risk patients to be treated more intensively. The purpose of this study was to determine the Boey and PULP scores in predicting mortality in gastric perforation patients. **Methods:** This retrospective observational study was conducted at the RSMH Medical Record Installation. Data that met all inclusion criteria and no exclusion criteria were analyzed descriptively, and the diagnostic value was determined using SPSS. **Results:** A total of 44 subjects with gastric perforation and treated with exploratory laparotomy during 2020–2021 were enrolled in the study, the majority of which were male (68.2%) with a mean age of 60.57±12.79 years. The Boey score showed that high and low-risk subjects were comparable (50.0%), and the majority were low risk based on the PULP score (56.8%). We found a significant difference in age (P=0.006), creatinine level (P=0.002), and length of stay (P=0.001) between those who were deceased and survived. The accuracy of Boey's score at the cut-off point of 1.5 is less good (0.591) with: 57.1% sensitivity, specificity of 62.5%, 0.727 PPV, and 0.591 NPV. The accuracy of the PULP score at the cut-off point of 4.5 is good (0.750) with a sensitivity of 78.6%, specificity of 68.8%, 0.815 PPV, and 0.647 NPV. **Conclusion:** The PULP score has better accuracy than the BOEY score in predicting mortality in gastric perforation patients.

1. Introduction

Gastric perforation is tissue damage in the gastric wall that causes direct contact between the gastric lumen and the peritoneal cavity.[1] Varied clinical features and frequent delays in diagnosis and examination in the hospital are the potential to cause worsening of symptoms and deterioration of clinical condition with adverse outcomes.[1,2] Incidence of gastric perforation varies between 3.3–5.3 per 100,000 in females and 4.2–8.7 per 100,000 in males. The gastric perforation mortality rate is 20%, and its complications are reported in 20–50% of patients.[3-6]

Scoring systems such as the Boey Score and the Peptic Ulcer Perforation (PULP) Score have been proposed to predict gastric perforation-associated mortality.[7-9] The accuracy of each of these scoring systems gives different results in each study. For example, Møller et al. showed 0.83 accuracies of the

PULP score, 0.70 for the Boey's score, and 0.78 for the American Society of Anesthesiologists (ASA) score in predicting mortality of peptic ulcer perforation.[10] In the study by Nichakankitti et al., the accuracy of the Boey score is 0.728, the ASA score 0.776, Manheim Peritonitis Index (MPI) 0.771, and PULP score 0.784.[11] Research conducted by Saafan et al. also showed the accuracy of the PULP score is 0.72, ASA scores 0.69, and Boey score 0.69.[12] Other studies also still provide varied answers to this comparisons.

In order to manage gastric perforation in patients and improve survival rates, it is important to classify patients into different categories based on possible morbidity and mortality so that high-risk patients can be treated more intensively. The incidence of gastric perforation in Dr. Mohammad Hoesin Palembang General Hospital (RSMH) from March 2010 to August 2011 in 40 cases, with an outcome of 40% dying patients (n = 16).[15] However, there is no data on the comparison of Boey and PULP scores in cases of gastric perforation at Dr. Mohammad Hoesin General Hospital. The purpose of this study was to compare the accuracy of using the Boey Score and PULP in predicting mortality in patients with gastric perforation at Dr. Mohammad Hoesin General Hospital.

2. Methods

This study is an observational retrospective study to compare the accuracy of the Boey scoring system and the PULP in assessing gastric perforation mortality risk in hospitalized patients at RSMH throughout 2020–2021. Included subjects are patients aged >18 years who were diagnosed with gastric perforation and underwent exploratory laparotomy. The study exclusion criteria are (1) gastric perforation due to trauma, (2) death from causes other than gastric perforation, and (3) incomplete patient medical record data.

Samples were taken from secondary data in the form of subject medical records in 2021 until they met the number of samples needed; 2020 data is used if the sample has not been met.

The data will be analyzed using descriptive, bivariate, and diagnostic tests analysis. Descriptive analysis was conducted to determine the general and clinical characteristics of the subjects. Bivariate analysis used: (1) Fisher Exact or Pearson Chi-Square test for categorical variables; and (2) independent T or Mann Whitney test for numerical variables; was conducted to determine the significance of differences in the characteristics of subjects who died and survived. Diagnostic test analysis uses a receiver operating curve (ROC) to determine the area under the curve (AUC) and the cut-off point value based on the best diagnostic parameter values.

3. Results

Data were collected and taken at the RSMH Medical Record Installation from January–to April 2022. The subjects were 44 people: 28 subjects were deceased (63.6%), and 16 survived (36.4%).

General characteristics

The majority of patients with gastric perforation who underwent exploratory laparotomy were male (68.2%) with a mean age of 60.57±12.79 years (ranged 19–88 years).

Clinical characteristics

Table 1 shows categorical variables of the clinical characteristics of the subjects. The majority of subjects have creatinine levels of >1.47 g/dL (68.2%). Only 6.8% of patients experienced a preoperative shock. The most type of surgery performed is an omental patch (88.6%). Most of the subjects have American Society of Anesthesiologists (ASA) II and III status with a percentage of 47.7%. Most comorbid in this study was the use of NSAIDs (52.3%). Corpus is the most common location of the perforation (50.0%).

Table 1. Clinical characteristics (Categoric variable)

Variables	n	%
Creatinine		
>1,47 g/dL	30	68,2
≤1,47 g/dL	14	31,8
ASA status, n (%)		
ASA II	21	47,7
ASA III	21	47,7
ASA IV	2	4,5
Pre-operative Shock		
Shock	3	6,8
Not shock	41	93,2
Type of Surgery		
Omental plaque	4	9,1
Omental patch	39	88,6
Primary suture	1	2,3
Comorbidities		
Nothing	15	34,1
NSAIDs	23	52,3
Steroids	1	2,3
DM	1	2,3
Hypertension	1	2,3
NSAIDs + DM	2	4,5
NSAIDs + DM + Hypertension	1	2,3
Location of Perforation		
Pre-pyloric	14	31,8
Pyloric	2	4,5
Corpus	22	50,0
Fundus	2	4,5
Antrum	3	6,8
Cardia	1	2,3
Boey Score		
High-risk	22	50,0
Low-risk	22	50,0
PULP Score		
High-risk	19	43,2
Low-risk	25	56,8

n, number; %, percentage; ASA, American Society of Anesthesiologists; NSAIDs; non-steroidal anti-inflammatory drugs; DM, diabetes mellitus; PULP, Peptic Ulcer Perforation.

In this study, numerical variables showed that patients with gastric perforation who underwent exploratory laparotomy had a mean onset of 2.682±1.410 days (range 1–7 days), mean length of treatment of 6.614±4.282 days (range 1–18 days), and mean length of surgery 2.06 ± 0.477 hours (range 1 to 3 hours). The numerical clinical characteristics of the subjects are shown in Table 2.

Table 2. Clinical characteristics (Numerical variable)

Variables	Value
Onset (days)	
Mean±SD	2,682±1,410
Median (Min-Max)	2 (1–7)
Length of treatment (days)	
Mean±SD	6,614±4,282
Median (Min-Max)	6 (1–18)
Length of surgery (hours)	
Mean±SD	2,061±0,477
Median (Min-Max)	2 (1–3)

n, number; %; percentage; SD, standard deviation; min, minimal; max, maximal.

Characteristics of gastric perforation patients based on mortality

Based on the analysis of categorical variables, we found a significant difference in creatinine levels (P=0.002) between gastric perforation patients who died and survived. However, no significant difference was found for gender difference (P=0.521); ASA status (P=0.254); preoperative shock (P=0.290); type of operation (P=0.639); comorbid (P=0.651); the location of the perforation (P=0.516). Patient characteristics based on mortality on categorical variables are detailed in table 3.

Table 3. Characteristics of gastric perforation patients based on mortality (categoric variable)

Variable	Mortality		*P-Value*
	Yes (n = 28)	No (n = 16)	
Gender, n (%)			
Male	18 (64,3)	12 (75,0)	0,521[a]
Female	10 (35,7)	4 (15,0)	
Creatinine			
>1,47 g/dL	24 (85,7)	6 (37,5)	0,002[a]*
≤1,47 g/dL	4 (14,3)	10 (62,5)	
ASA status, n (%)			
ASA II	11 (39,3)	10 (62,5)	0,254[b]
ASA III	16 (57,1)	5 (31,3)	
ASA IV	1 (3,6)	1 (6,3)	
Pre-operative Shock			
Shock	3 (10,7)	0 (0,0))	0,290[a]
Not shock	25 (89,3)	16 (100)	
Type of Surgery			
Omental plaque	2 (7,1)	2 (12,5)	0,639[b]
Omental patch	25 (89,3)	14 (87,5)	
Primary suture	1 (3,6)	0 (0)	
Comorbidities			
Nothing	8 (28,6)	7 (43,8)	
NSAIDs	14 (50,0)	9 (56,3)	
Steroids	1 (3,6)	0 (0)	0,651[b]
DM	1 (3,6)	0 (0)	
Hypertension	1 (3,6)	0 (0)	
NSAIDs + DM	2 (7,1)	0 (0)	
NSAIDs + DM + Hypertension	1 (3,6)	0 (0)	
Location of Perforation			
Pre-pyloric	8 (28,6)	6 (37,5)	
Pyloric	1 (3,6)	1 (6,3)	
Corpus	15 (53,6)	7 (43,8)	0,516[b]
Fundus	1 (3,6)	1 (6,3)	
Antrum	3 (10,7)	0 (0)	
Cardia	0 (0)	1 (6,3)	

n, number; %, percentage; ASA, American Society of Anesthesiologists; NSAIDs; non-steroidal anti-inflammatory drugs; DM, diabetes mellitus; [a]Fisher Exact test; [b]Pearson Chi-Square test; *P<0,05.

Furthermore, statistical analysis of numerical variables proved that there is a significant difference in age (P=0.006) and length of stay (P=0.001). In contrast, no significant difference is found at onset (P=0.655); and duration of operation (P=0.149) between gastric perforation patients who deceased and survived. Patient characteristics based on mortality on numerical variables are detailed in Table 4.

Table 4. Characteristics of gastric perforation patients based on mortality (Numerical variable)

Variable	Mortality		*P*-value
	Yes (n = 28)	No (n = 16)	
Age (years)			
Mean±SD	64,5±9,93	53,69±14,57	0,006[a]*
Median (Min-Max)	62,5 (50 – 88)	53,5 (19 – 80)	
Onset (days)			
Mean±SD	2,714±1,357	2,625±1,544	0,655[b]
Median (Min-Max)	2 (1 – 7)	2 (1-7)	
Length of treatment (days)			
Mean±SD	5,536±4,747	8,500±2,422	0,001[b]*
Median (Min-Max)	4 (1 – 18)	7,5 (6 – 13)	
Length of surgery (hours)			
Mean±SD	2,132±0,489	1,938±0,443	0,149[b]
Median (Min-Max)	2 (1 - 3)	2 (1 – 3)	

n, number; %; percentage; SD, standard deviation; min, minimal; max, maximal; [a]independent T test; [b]Mann-Whitney test; **P*<0,05.

Accuracy of the Boey and PULP scoring system in the assessment of mortality in gastric perforation patients underwent laparotomy exploration

To find the cut-off point for the Boey score in the mortality assessment, we used ROC analysis.

Boey Score

With ROC, we obtained the cut-off point of the Boey score of 1.5 for the best sensitivity and specificity values (Figure 1).

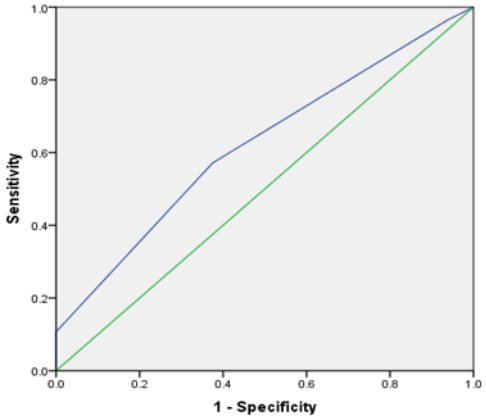

Figure 1. Boey score ROC

After the diagnostic test, the Boey scoring system has: a sensitivity of 57.1%; specificity of 62.5%; positive predictive value (PPV) of 0.727; negative predictive value (NPV) of 0.591; and the accuracy between the Boey scoring system and the mortality of gastric perforation patients was poor (0.591) (Table 5).

Table 5. Boey score outcome

Outcome		Mortality		Total
		Deceased	Survived	
Boey Score	≥1,5	16	6	22
	<1,5	12	10	22
Total		28	16	44

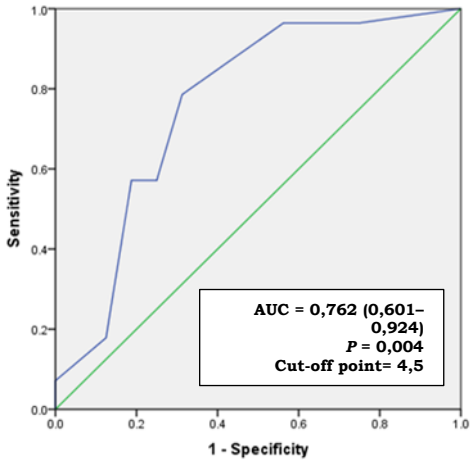

Figure 2. PULP score ROC

PULP Score

The cut-off point value of the PULP score based on ROC with the best sensitivity and specificity value is 4.5 (Figure 2). Based on the cut-off point, the PULP scoring system has a sensitivity of 78.6%, specificity of 68.8%, a positive predictive value of 0.815; a negative predictive value of 0.647; and the accuracy between the PULP scoring system and mortality in gastric perforation patients was good (0.750) (Table 6).

Table 6. PULP score outcome

Outcome		Mortality		Total
		Deceased	Survived	
Boey Score	≥1,5	22	5	27
	<1,5	6	11	17
Total		28	28	16

Table 7. Accuracy of the Boey and PULP Scoring System in the assessment of mortality in patients with gastric perforation who underwent laparotomy exploration (by cut-off point)

Value	Boey Score	PULP Score
Cut off point	1,5	4,5
AUC (95% CI)	0,621 (0,452–0,789)	0,762 (0,601–0,924)
Accuracy	0,591	**0,750**
Sensitivity	57,1	**78,6**
Specificity	62,5	**68,8**
PPV	0,727	**0,815**
NPV	0,455	**0,647**

PULP, Peptic Ulcer Perforation; AUC, the area under the curve; CI, confidence interval; PPV, positive predictive value; NPV, the negative predictive value.

4. Discussion

Gastric perforation is a serious complication of peptic ulcers. Patients with gastric perforation are often accompanied by acute abdominal symptoms and have a high risk of mortality and morbidity. Abdominal pain with sudden onset, tachycardia, and muscular tenderness is the classic triad of gastric perforation.[14] In this study, the majority of patients with gastric perforation were male (68.2%). This result is not much different from the study of Koto et al., 2016 in North Sumatra, which reported that the majority of gastric perforation patients were male (78.6%).[15] Likewise, Yeboah and Togbe's 2007 study in Ghana reported that there were more gastric perforation patients in males (70.7%) rather than females (29.3%).[16]

In this study, patients with gastric perforation have

a mean age of 60.57±12.79 years with a range of 19–88 years. The Yeobah and Togbe study reported that the age range of patients with perforation was 17–95 years, with a mean age of 55.2±15.8 years and 65.2±7 years according to the type of ulcer.[16] In the study of Koto et al., it was reported that 47–53 and 61–67 are the most common age group that frequently experienced gastric perforation. The least age group is 40–46 years.[15] The results of these studies are in accordance with the previous theory, which states that gastric perforation is rare under 40 years of age, and the peak incidence is at the age of 55–65 years (Koto et al.).[15] Based on the mortality outcome, there was a difference in age between patients with gastric perforation who died and those who lived. Patients with gastric perforation who died had a significantly older age than patients who survived.

Laboratory tests are essentially non-specific for diagnosing gastric perforation. Laboratory tests are also performed not to diagnose but to rule out the possibility of a differential diagnosis and to understand the state of the patient's organ systems. This is because the examination is less specific.[17] In this study, based on the PULP scoring, it was found that 68.2% of patients with gastric perforation had creatinine levels >1.47 g/dL. Based on the mortality outcome, perforated patients who deceased have creatinine levels >1.47 g/dL with a higher percentage than the survived patients (85.7% vs. 37.5%).

Non-steroid anti-inflammatory drugs (NSAIDs) are a major risk factor for acute ulcers and their bleeding complications.[18] In this study, more than 50% of patients with gastric perforation had a history of NSAID use. However, based on the mortality outcome, there was no difference in the history of NSAID use between patients with gastric perforation who deceased and those who survived. In both outcome groups, NSAID use was found in more than 50% of patients. The systemic effects of NSAID use are caused by inhibition of endogenous prostaglandin synthesis. This prostaglandin inhibition reduces epithelial mucus production, bicarbonate secretion, mucosal blood flow, epithelial proliferation, and mucosal resistance to trauma. The imbalance of mucosal resistance results in mucosal damage by endogenous factors such as pepsin, acids, and bile salts, and exogenous factors such as NSAIDs, ethanol, and other harmful substances.

The average length of hospitalization for gastric perforation patients in this study was 6.6 days, with a range of 1 to 18 days. Patients with gastric perforation who deceased had a significantly shorter length of stay than patients who survived. This is because several gastric perforation patients died within a few days of hospitalization. As many as 23 of 28 (82%) gastric perforation patients who died were treated for less than one week.

For other characteristics, there were no differences in gender, ASA status, preoperative shock, type of surgery, location of the perforation, onset, and duration of surgery between patients with gastric perforation who died and lived. This means that mortality in patients with gastric perforation is not affected by these characteristics.

Several risk assessments to predict outcomes in patients with gastric perforation have been developed. The Boey scoring method is a commonly used method because of its simplicity and high predictive value in assessing mortality in gastric perforation.[19] In this study, the cut-off point of the Boey score, which had the best sensitivity and specificity value, is 1.5. The Boey scoring system in predicting mortality in this study had a sensitivity of 57.1% and a specificity of 62.5%. This means that the ability of the Boey scoring system to predict death in gastric perforation patients is only 57.1%, while the ability of the Boey scoring system to rule out the presence of gastric perforation is only 62.5%. A study by Anand et al. in 2018 showed that the sensitivity and specificity of the Boey score were greater than this study, namely 75% and 74.1%.[20] In the Saafan et al. study in 2019, it was reported that the Boey score with a cut-off point of 1 had a greater sensitivity of 76.47% but a lower specificity value of 45.19%.[12]

In addition to the Boey scoring system, there is also a new peptic ulcer perforation (PULP) scoring method

to predict the clinical course of gastric perforation.[16] In this study, the PULP score cut-off point, which had the best sensitivity and specificity values, is 4.5. The PULP score has greater sensitivity and specificity than the Boey score, namely 78.6% and 68.8%. This means that the ability of the PULP scoring system to predict death in gastric perforation patients is 78.6%, while the PULP scoring system's ability to rule out the presence of gastric perforation is 68.8%. Research by Anand et al. in 2018 suggests that the sensitivity and specificity of the PULP score were greater than this study, namely 100%; and 92.6%.[20] In addition, research conducted by Kurniawati et al. in 2019 also found a sensitivity value that was greater than this study, namely 91.7%, but its specificity is smaller (65.4%) with a PULP cut-off point of 7.21. Another study conducted by Saafan et al. in 2019 shows that the PULP score with a cut-off point of 3 had a lower sensitivity of 64.71% but a higher specificity value of 74.63%.[12]

The accuracy between the Boey scoring system and the mortality of gastric perforation patients in this study was poor (0.591), while the accuracy between the PULP scoring system and the mortality of patients with gastric perforation was good (0.750). Based on the accuracy, it can be concluded that the PULP score system has better accuracy than the BOEY score in predicting mortality in gastric perforation patients. These results are supported by the research of Anand et al., who also concluded that the PULP score system has better accuracy than the BOEY score in predicting patient mortality.[20]

5. Conclusion

The PULP scoring system has better accuracy than the BOEY scoring system in predicting mortality in gastric perforation patients. However, further studies in a prospective cohort of patients with gastric perforation using primary data and larger sample size need to be conducted to confirm and strengthen the results of this study. The PULP score can be proposed as the main reference for the prediction of mortality in gastric perforation patients.

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